FUEL CELL

Technical Field

The present invention relates to fuel cells, and more particularly, to a fuel cell which can enhance an electricity generating performance.

Background Art

The fuel cell is an energy transformation device for direct transformation of a chemical energy of a fuel into an electrical energy by means of chemical reaction. Different from a general battery, the fuel cell can generate electricity continuously as far as fuel is fed without recharging. Recently, interest is focused on the fuel cell owing to the high energy efficiency, and the environment friendly nature.

In general, the fuel cell is provided with two electrodes, i.e., an anode and a cathode arranged on opposite sides of electrolyte. In general, there are an anode side separator on an outer side of the anode having a fuel passage and supporting the anode, and a cathode side separator on an outer side of the cathode having an air passage and supporting the cathode. An electro-chemical reaction of the hydrogen, the fuel, takes place at the anode, and an electro-chemical reaction of the oxygen, an oxidizer, takes place at the cathode, and electric energy is generated owing to immigration of electrons taken place in this time.

The fuel cell may use a variety of fuels, such as LNG, LPG, methanol, gasoline, and the like. In general, the fuel is refined as hydrogen by passing through a desulfurization process, a reforming reaction, and a hydrogen refining process at a fuel reformer, and used in a form of gas. A fuel of a water solution state, for an example, a solid state BH_4^- is dissolved into a water solution state, is used as fuel (Boro Hydride Fuel Cell). The Boro Hydride Fuel Cell (BFC) can dispense with the fuel reformer as fuel of a water solution state is fed to the anode directly, and the reforming reaction

takes place at the anode without the fuel reformer, enabling to simplify a fuel cell system.

In the meantime, according to kinds of the electrolytes, there are phosphoric fuel cells, molten carbonate fuel cells, alkaline fuel cells, solid oxide fuel cells, and polymer membrane fuel cells, and the like.

A related art fuel cell system will be described with reference to FIG. 1.

Referring to FIG. 1, fuel is fed from a fuel tank 5 to a fuel cell 1 by a fuel pump 3, and air is fed to the fuel cell 1 by an air pump 7. The fuel cell 1 is a unit cell or a stack of the unit cells.

An example of a related art fuel cell will be described with reference to FIGS. 2 to 4. Each of FIGS. 2 to 4 illustrates a unit fuel cell.

There are an anode 30 and a cathode 20 at opposite sides of electrolyte 10. There are separators 40 and 50 at outer sides of the anode 30 and the cathode 20, respectively. The anode 30 and the cathode 20 are porous and in general include Pt catalyst.

Thus, there are an anode side separator 50 at an outer side of the anode 30, and a cathode side separator 40 at an outer side of the cathode 20. The separators 40 and 50 support the anode 30 and the cathode 20 respectively, and have passages 46, and 56 formed in general between barriers 44, and 54. There can be a variety of passage forms. The separators 40, and 50 serve to separate individual unit cells when unit cells are stacked. In the meantime, there can be separate electricity collecting plates at outer sides of the separators 40, and 50, respectively.

In general, the electrolyte is an ion exchange membrane of a polymer material. A typical commercially available electrolyte membrane is Nafion membrane of Du Pont, and serves as a transfer body of hydrogen ions, and, at the same time with this,

prevents the oxygen from coming into contact with hydrogen. The anode 30 and the cathode 20 are supporting bodies having catalyst attached thereto of, in general, porous carbon resin or carbon cloth. The separators 40, and 50 are formed of, in general, dense carbon material, or Ni/SUS material.

The action of the fuel cell will be described.

The fuel and air fed to the fuel cell flow through the anode 30 and the cathode 20, and make the following chemical reaction.

Anode : $BH_4^- + 8OH^- \rightarrow BO_2^- + 6H_2O + 8e^-$ $E_0 = -1.24V$

Cathode:$2O_2 + 4H_2O + 8e^- \rightarrow 8OH^-$ $E_0 = 0.4V$

Total : $BH_4^- + 2O_2 \rightarrow 2H_2O + BO_2^-$ $E_0 = 1.62V$.

In the meantime, in order to make the BH_4^- stable solution, in general a certain amount of Na is mixed, to cause a side reaction to generate hydrogen gas at the anode 30. That is, a reaction of $2H_2O + NaBH_4 \rightarrow NaBO_2 + 4H_2$ takes place at the anode 30.

In the meantime, improvement of an electric generating capacity, and performance of the fuel cell have been required while a size of the fuel cell is kept as it is. Because, despite of above advantages of the fuel cell, the size of the fuel cell becomes in general larger for obtaining desired electric generating capacity and performance, that limits use of the fuel cell, and is not convenient in use.

Consequently, there have been many suggestions for improving the capacity and performance of the fuel cell. For an example, Japanese Laid Open Patent No. H10-228913 suggests partial gold plating of electrodes and separators, to reduce contact resistances between the electrodes and the separators, to improve the performance of the fuel cell. In this instance, it is suggested that the separators are

formed of metal, and the separators are formed of stainless steel for prevention of corrosion. However, though the various suggestions for improving the capacity and performance of the fuel cell have effects in some extent, the effects are not in general significant, to require fuel cells having a better electric generating performance.

Disclosure of Invention

An object of the present invention, designed to solve above problems, is to provide a fuel cell which can improve an electric generating capacity and performance without increasing a size of the fuel cell.

The object of the present invention can be achieved by providing a fuel cell including electrolyte, an anode and a cathode at opposite sides of the electrolyte, an anode side separator and a cathode side separator at outer sides of the anode and the cathode respectively, and a medium layer between the cathode and the cathode side separator for prevention of corrosion of the cathode side separator.

In other aspect of the present invention, there is provided a fuel cell including electrolyte, an anode and a cathode at opposite sides of the electrolyte, an anode side separator at an outer side of the anode, a cathode side separator at an outer side of the cathode, a porous supporting member between the cathode and the cathode side separator for supporting the cathode, and a supporting member medium layer between the cathode and the porous supporting member for prevention of corrosion of the porous supporting member.

In another aspect of the present invention, there is provided a fuel cell including electrolyte, an anode and a cathode at opposite sides of the electrolyte, an anode side separator and a cathode side separator at outer sides of the anode and the cathode respectively, and a medium layer between the anode and the anode side separator for prevention of corrosion of the anode side separator.

Thus, an electric generating performance of the fuel cell can be improved, to enable improvement of an electric generating capacity without increasing a size of the fuel cell.

Brief Description of Drawings

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention.

In the drawings;

FIG. 1 illustrates a block diagram of a related art fuel cell system;

FIG. 2 illustrates a disassembled perspective view of a related art fuel cell, schematically;

FIG. 3 illustrates a plan view of one example of the cathode side separator in FIG. 2, schematically;

FIG. 4 illustrates a section of FIG. 2;

FIG. 5 illustrates a circuitry expression of the fuel cell in FIG. 2;

FIG. 6 illustrates a graph of a voltage drop in the fuel cell;

FIG. 7 illustrates a section of a fuel cell in accordance with a preferred embodiment of the present invention, schematically;

FIGS. 8 and 9 illustrate graphs each showing comparison of electric generating capacity of the fuel cells of the present invention and the related art; and

FIG. 10 illustrates a section of a fuel cell in accordance with another preferred embodiment of the present invention, schematically.

Best Mode for Carrying Out the Invention

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. In

describing the embodiments, parts identical to the parts of the related art fuel cell will be given the same names and reference symbols, and detailed description of which will be omitted.

A preferred embodiment of the fuel cell of the present invention will be described with reference to FIG. 7.

Alike the related art, the fuel cell of the present invention includes electrolyte 10, an anode 30, a cathode 20, an anode side separator 50, and a cathode side separator 40. Though the separator 40 or 50 has one side in contact with the anode 30, and the other side in contact with the cathode 20 at the same time in a stack type fuel cell having a plurality of unit cells stacked therein, for the sake of description, words of an anode side separator 50, and a cathode side separator 50 will be used in the following description.

From study of the inventors, it is found out that prevention of corrosion of the separators, particularly, the cathode side separator 40 is very important for improving performance of the fuel cell. Because, as shown in FIG. 5, when the fuel cell generates electricity, ions move from the anode → the electrolyte → the cathode, and electrons move from the anode (r2) → the anode side separator (r1) → the cathode side separator (r4) → the cathode (r3), wherein all the moving paths of the electrons are a kind of inner resistances. By the way, as shown in FIG. 6, if the inner resistance increases, a performance of the fuel cell drops according to I-V characteristics of the fuel cell. In the meantime, from the study of the inventors, it is found out that, during operation of the fuel cell, in general, corrosion takes place at the cathode side separator 40, and stain formed in this instance is a great cause of the increase of the inner resistance. That is, the related art of the present invention fails to know that the prevention of corrosion of the separator 40 is one of the most important factors for

improving the performance of the fuel cell. Therefore, as described in the related art, Japanese Laid Open Patent No. H10-228913 suggests partial gold plating at contact surfaces of electrodes and separators, to reduce contact resistances between the electrodes and the separators simply, and to use stainless steel as a material of the separators for prevention of corrosion. However, in general, it is difficult to avoid the corrosion effectively by using the separator of metal, particularly, the corrosion of the cathode side separator causes problems. That is, from study of the inventors, it is found out that positive corrosion prevention is more effective than prevention of simple contact resistance for improving the performance of the fuel cell.

Therefore, the present invention suggests preventing corrosion of the separator for improving performance of the fuel cell. Though any methods that can effectively prevent corrosion of the cathode side separator are applicable, a method in the following embodiment is simple and effective.

Referring to FIG. 7, there is a medium layer 300 between the cathode side separator 40 and the cathode 40 for prevention of corrosion of the cathode side separator 40. Though the medium layer 300 may be provided separately, it is preferable that the medium layer 300 is a coated layer of a material selected from materials having ionization tendencies similar to the cathode 20. Because it is found out from the study of the inventors that a principal cause of the corrosion at the cathode side separator 40 is a voltage difference coming from a difference of the ionization tendencies of the cathode 20 and the cathode side separator 40.

In the meantime, it is required that the coated layer 300 on the cathode side separator 40 is at least on a contact surface 302 to the cathode 20, and a bottom surface 304 of the passage, and preferably on a wall surface 306 of the passage.

In the meantime, in general, since the cathode 20 includes a Pt catalyst, the

coated layer 300 may be formed of Pt, gold, copper, nickel, and the like having ionization tendency the same or similar to Pt, and it is preferable that the coated layer 300 is formed of gold, taking production cost, and process, and the like into account.

On the other hand, the corrosion may take place at the anode side separator 50. Therefore, it is preferable that a medium layer (not shown), for an example, the coated layer, is formed on the anode side separator 50 for prevention of corrosion of the anode side separator 50. Of course, in this instance too, it is preferable that the coated layer is formed of a material selected from materials that show no voltage differences from the anode 30.

Referring to FIG. 8, as a result of experiment of the inventors, in a case of a fuel cell with the cathode side separator 40 including Pt, it is verified that the fuel cell with a gold coated layer can improve approx. 50% of electric generating performance compared to the related art fuel cell without the coated layer if other conditions are the same. Since results of experiments for various kinds of fuel cells show similar trends, only one result of the experiment is shown in FIG. 8 for convenience.

Moreover, as shown in FIG. 9, the principle of the present invention is applicable to other forms of fuel cells. For an example, as shown in FIG. 10, there may be a porous supporting member 100, for an example, a mesh member, between the cathode 20 and the cathode side separator 40. The supporting member 100 is also corroded, and it is preferable that such corrosion is prevented. That is, gold plating on the supporting member 100 reduces the inner resistance, and shows performance improvement. Of course, it is more effective if the cathode side separator 40 is coated with gold.

In the meantime, there can be an anode supporting member 80 between the anode 30, and the anode side separator 50, and the same principle is applicable to the

anode supporting member 80.

Of course, the principle of above embodiments is not limited to a fuel cell of the BFC type, but is applicable to other fuel cells, too.

Industrial Applicability

The effective prevention of corrosion at the cathode side separator and/or the anode side separator permits to reduce an inner resistance of the fuel cell, to improve electric generating performance, and capacity, at the end.